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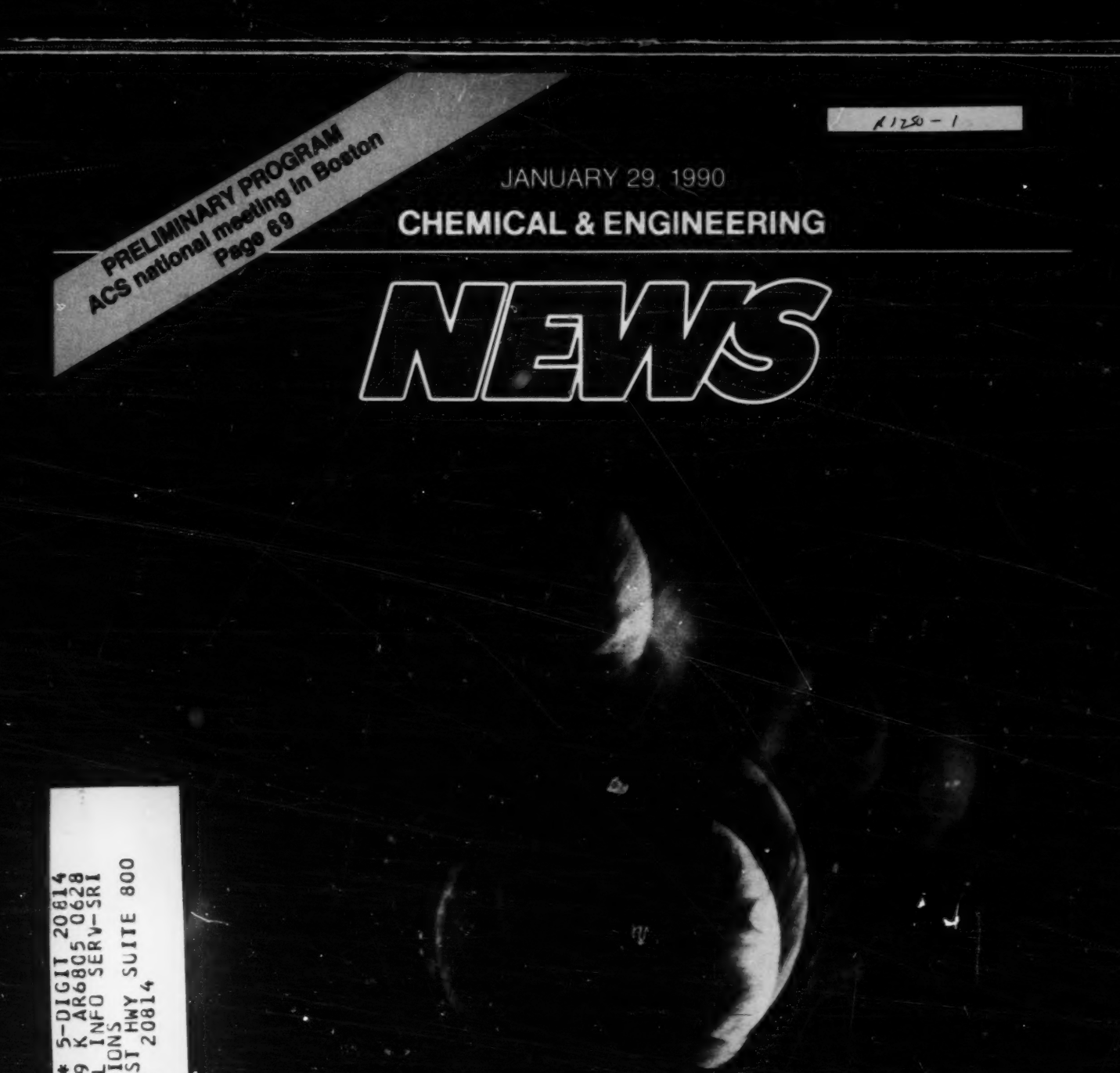
PRELIMINARY PROGRAM
ACS national meeting in Boston
Page 69

JANUARY 29, 1990

CHEMICAL & ENGINEERING

NEWS



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SOAPS AND DETERGENTS

Producers developing new products and strategies for the 1990s
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CHEMICAL & ENGINEERING
NEWS
JANUARY 29, 1990

Volume 68, Number 5
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News of the Week

■ **Wave of restructuring in the pharmaceutical industry continues with the purchase of Rorer by France's Rhône-Poulenc.** Page 4

■ **Hercules will report a net loss in 1989 because of unrecoverable cost overruns and sales that didn't materialize of its rocket motors.** Page 5

■ **Bills to boost the Environmental Protection Agency to membership in the Cabinet have been endorsed by President Bush.** Page 5

■ **An appeals court has overturned the conviction of three Chicago company executives for involuntary manslaughter in the work-related death of an employee.** Page 6

■ **Action to head off the looming shortage of technical Ph.D.s was urged recently by both the Secretary of Education and the Association of American Universities.** Page 6

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Business

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Science Policy

White paper on Japanese science and technology policy makes obvious U.S.'s less focused approach. **Page 21**

Science/Technology

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Detergent industry producers plan for a new decade with products that will meet environmental demands and consumer needs. **Page 37**

Chemical & Engineering News

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LETTERS

High-strength fiber

SIR: Reading Stu Borman's article on the new high-strength fiber, Spectra (C&EN, Oct. 9, 1989, page 23), currently under development at Allied-Signal, I am surprised to see no reference to the original inventors of ultradrawn polyethylene. The foundation for the gel-spinning of ultrahigh molecular weight polyethylene was laid in the 1970s at the University of Groningen, the Netherlands. The commercial production of the so-called Dyneema fiber at DSM was taken up in 1983 after the granting of a patent to P. J. Lemstra (Technical University Eindhoven) and P. Smith (currently at the University of California, Santa Barbara).

In the perspective of the recent dramatic struggle between Akzo and Du Pont on the Twaron-Kevlar fiber, one would expect U.S. science journalism to be more respectful of European innovations.

Albert H. Alberts
Technical University Eindhoven
The Netherlands

Procedure for cyanide waste

SIR: J. A. Singmaster (C&EN, Nov. 6, 1989, page 2) again argues against the safety of the procedure for the laboratory destruction of cyanide waste by hypochlorite solution that is in the National Research Council's "Prudent Practices for Disposal of Chemicals from Laboratories." There are flaws in his argument.

W. L. Faust's article in *Science* does not say that cyanate and thiocyanate salts are explosive; it points out that metal salts of azides, fulminates, isocyanates, and isothiocyanates are similar in chemical and crystal structure and then says that explosives included among these are azides and fulminates.

Cyanate is not reduced to cyanide by ferrous ion—nor by hydrogen iodide, sulfur dioxide, or sodium sulfide [Williams, "Cyanogen Compounds," Edward Arnold, London, page 68 (1948)].

The reaction of cyanate with hypochlorite to form nitrogen is sensitive to pH and temperature. For instance, at 25 °C it is rapid at pH 4 to 8; very slow at pH 11 to 12. Singmaster may not have been working under the right conditions to get nitrogen. Whatever caused the acrid odor that he observed was probably not ClNCO, which is unstable even at 0 °C and is rapidly hydrolyzed by water [Nachbaur and Gottardi, *Monatsch. Chem.*, **97**, 115 (1966)].

Hence the conclusions of John Pilznienski (C&EN, April 22, 1985, page 2) and Blaine McKusick (C&EN, May 13, 1985, page 2) in response to Singmaster's first letter (C&EN, Feb. 18, 1985, page 2) are still valid. Cyanates do not detonate, do not isomerize to fulminates, and have a limited lifetime in water. The NRC procedure for disposing of laboratory cyanide waste is safe and appropriate.

Blaine C. McKusick
Wilmington, Del.
John F. Pilznienski
Kolene Corp., Detroit

Attacks on chemical industry

SIR: James Sims is right: The American Chemical Society must get its head out of the sand (C&EN, Oct. 23, 1989, page 3). As a 30-plus-year member of the society it is disconcerting to see how ineffectually the society meets the attacks upon the chemical industry. Entering the political arena to prevent the industry's being legislated out of existence is fine. However, chemists need to reach a consensus on some serious problems and misunderstandings as the first order of business. Why?

The society is being outmuscled by well-financed groups who have become our spokesmen to the media and Congress—strictly by default. Chemists have a record of communicating poorly, or not at all. Where are we missing the boat? Here is where I think that the society could help: It must promote discussion on the most relevant environmental issue today. That is zero-risk and safety, for all issues converge here.

Regarding zero-risk, traces of Alar on apples created a national furor; as a suspected carcinogen it was dangerous to children. This episode is a paradigm of the mind-set of all who insist that all traces of supposedly toxic chemicals must be eliminated. To a scientist, what is wrong with this idea? First, present day analytical methods are so powerful that the minutest traces of a substance can be detected; traces mean nothing, of themselves, unless related to safety (toxicity) of that substance. Second, what about the phenomenom of hormesis: The rather surprising idea that small amounts of a nonnutrient (even toxins, radiation) may be beneficial to humans? The principle is supported by some outstanding scientists, including B. L. Cohen, T. D. Luckey, and P. Beckmann, among others. Clearly, there would be no immunity in *Homo sapiens* if all traces of disease-causing bacteria and viruses were eliminated, and risks of exposure were zero!

On the issue of safety, why can't we be completely safe? First, our methods

Continued on page 88

Chemical Industry, Drug Agency Sort Out Chemical Diversion Issues

House hearings on recently implemented chemical diversion and trafficking law examine its workability as well as its effectiveness

David J. Hanson, C&EN Washington

The government's efforts to curtail the use of illegal drugs in the U.S. have taken a variety of forms. Most visible, of course, has been the seizure of large quantities of cocaine from ships, planes, and warehouses where drug traffickers have hidden their illegal goods. A less visible effort began late last year to dry up the supplies of these drugs, particularly cocaine, by denying the drugmakers the chemicals needed to extract and purify their product.

The Chemical Diversion & Trafficking Act of 1988, which went into effect this past fall, is designed to monitor and halt the flow of legitimate chemicals into illegal uses. Still in the process of being fully implemented, the law requires chemical manufacturers, importers, or exporters of 12 chemicals that are precursors to illegal drugs or of eight chemicals that are considered essential to the making of those drugs, to maintain records on all transactions involving these compounds. The law will be used to track chemical diversions domestically and internationally. Most of the emphasis so far has been on Latin America because it may pose a tougher problem.

Companies are also supposed to report suspicious orders and provide advance notice to the Drug Enforcement Administration of imports and exports of these chemicals. The law gives the U.S. Attorney General the authority to suspend any imports or exports he or she determines may be diverted to illegal drug manufacturing.

The U.S. chemical industry has been trying to work closely with DEA officials to make sure the law is both workable and effective. Faced with the reality that some products of U.S. companies are being used to make cocaine in South America, the industry wanted to take at least partial responsibility for stopping this trade. But as noted during the course of hearings held by the House Select Committee on Narcotics Abuse & Control to determine how the law is working out in practice, several issues have arisen that are worrisome to the chemical industry.

As noted by Chemical Manufacturers Association spokesman Gene Browning, manager of product regulatory operations for the silicon plastics division of General Electric, these problems include difficulty in meeting DEA's requirements for identifying "regular customers," an unexpected requirement for businesses to keep receipt records, and an overall lack of clear interpretation and guidance from DEA for the regulated companies.

A basic problem is just how much U.S. product is being used to make cocaine in South America. DEA operations assistant administrator David L. Westrate says: "Although it is impossible to determine the exact percentage of U.S.-made chemicals that are used in the manufacture of cocaine, trade records and intelligence reports indicate that the U.S. is by far the largest exporter of chemicals to Latin America." DEA has stated in the past that as much as half the chemicals used in cocaine manufacture could have been diverted from U.S. shipments.

Only a few figures on chemicals seized in South America are available from DEA. In Westrate's testimony before the House committee, he states that from Jan. 1 to Sept. 18, 1989, "chemical seizures by the Colombian National Police included more than 620,000 gal of ether, almost 850,000 gal of acetone, nearly 120,000 gal of sulfuric acid, one-half million gal of methyl ethyl ketone, and more than 160,000 kilos of potassium permanganate." Westrate mentioned the discovery of several clandestine laboratories in Colombia, including one that had a 30-foot camouflaged exhaust tower and six 22,000-gal storage tanks hidden under a road. The point he was making, of course, is that the drugmakers have set up a major operation that requires a large volume of chemical supplies.

The chemical industry, represented by CMA and the Synthetic Organic Chemical Manufacturers Association, does not dispute that some chemicals may end up in the hands of drugmakers, but there is some disagreement about the quantity U.S manufacturers are responsible for. CMA, faced with DEA's claims of wholesale diversion of chemicals to cocaine production, did its own analysis of U.S. chemical exports to Latin America using data from the U.S. Commerce Department. General Electric's Browning stated: "Although we have not assessed the volume of legitimate uses in Latin America, the current export levels of essential chemicals appear largely consistent with legitimate end uses. Overall, the trade data tend to indicate that smaller volumes of U.S.-origin essential chemicals are being shipped to Colombia, and therefore are not generally a source of the problem in that country." In general, the industry belief is that DEA has overstated U.S. companies' contribution to cocaine production.

U.S. exports to Latin America small quantities of chemicals used for cocaine production

Millions of lb[a]	Bolivia	Brazil	Chile	Colombia	Panama	Peru	Venezuela	World
Acetone	0.03	7.85	1.82	4.67	0.62	0.09	8.89	220.98
Acetic anhydride	0	0	0	0	0	0	0	0
Benzyl chloride	na	na	na	na	na	na	na	na
Ethyl ether	0	0	0	0	0	0	0	0.46
Hydriodic acid	0	0.39	0.02	0.21	0.07	0.02	2.83	64.96
Methylamine	0	0.24	0.12	0.69	0	0	0.32	17.24
Methyl ethyl ketone	0	4.12	2.47	12.80	0.08	0.33	8.69	56.93
Potassium compounds	0.44	0.33	0.26	0.10	0	0.04	0.04	26.18
Toluene	0.02	0.02	2.12	0	1.73	1.10	5.30	75.97
TOTAL	0.49	12.95	6.81	18.47	2.50	1.58	26.07	462.72

a 1988. na = not available. Source: Chemical Manufacturers Association

A prime example appears to be potassium permanganate. This oxidizing agent is one of the regulated chemicals. DEA says it seized more than 12 million lb of the chemical during 1988 in Colombia and other cocaine-associated countries. But the U.S. only exported 19,845 lb of potassium permangate to Colombia in 1988, all from the same manufacturer and all to well-established customers. Most or all of the chemical being used for cocaine production must be coming from somewhere else. Both SOCMA and CMA believe a lot of the material is coming from Europe and Asia as well, and that until these sources are as controlled as U.S. exports, those making illegal drugs will have little trouble getting the chemicals they need.

Regardless of the quantity of chemicals being diverted, the law says companies must report sales of them so DEA can be sure the products are going to legitimate users. In getting to this goal, a few administrative wrinkles remain to be ironed out. One of the things a company can do is to get its long-standing customers status as a regular customer. This will ensure that orders can be shipped promptly.

If it is dealing with a regular customer, a company has to notify DEA at least 15 days in advance of a shipment so the federal agency can check out the integrity of the receiving company. Ronald W. Buzzeo, deputy director of DEA's Office of Diversion Control, says his office has received 288 requests seeking regular-customer status for companies in Latin America. "So far, we have denied 35 of these as either gone out of business, or because of known involvement with drug traffickers or brokers," Buzzeo says.

Identifying regular customers is still causing some confusion, according to CMA's J. Garrity Baker. "In most transactions, where a company already has established a relationship with its customer, orders are taken over the phone," Baker says. "There is no proof of identity made each time." Baker is concerned that the DEA regulations could be interpreted as requiring proof of identity for each transaction. "A guy would have to come into the office and present identification each time," he says.

Susan Kernus, manager of government affairs at SOCMA, says her organization is worried about how easy it would be for DEA to tighten its controls under the law. "DEA can expand its list of regulated products, or it can further limit granting of regular-customer status. We are really going to have to keep our eyes open."

These and other problems are being worked out between the chemical industry and DEA. Baker says CMA has been meeting regularly with the drug agency to implement the law, but no changes have been made in DEA's original rules. "We've talked about possible resolutions of these issues," Baker says, "but DEA has just said it will take them under advisement and get back to us later."

Internationally, a little progress is being made. A convention has been worked out through the United Nations and signed by 77 countries, says DEA's Buzzeo. So far, only four countries, including the U.S., have ratified it. The treaty, if fully ratified, would set up an international monitoring system like the one being set up in the U.S., so all producers of these chemicals would be keeping track of how they are being used. And it will take such international coordination to stop the cocaine production. "If the U.S. were to stop exporting all the regulated chemicals tomorrow, the cocaine makers would just start importing them from other countries the next day," says Baker.

The chemical industry is confident it can work with DEA to curb the drug problem. It may just be a matter of the two entities getting to know each other better. Baker says it is significant that the only previous industry DEA has worked with is pharmaceuticals, which is much different. "The pharmaceutical industry has fewer manufacturers, fewer products, and sales are made in a highly regulated environment," says Baker. "Sometimes I think that DEA is trying to regulate the chemical industry the same way and it doesn't work."

In addition, Baker points out that DEA is a different kind of agency than other government offices monitoring chemical business. "DEA people are largely specialized cops, and this is the mind-set they bring to the job. They are not just administrators. We are seen as part of the problem in their eyes. If we would just stop selling the chemicals that are being diverted, the cocaine problem would decrease. So there is going to be a different relationship given these attitudes." □

Technician tests series of cleaners on a ceramic tile substrate at BASF's labs in Wyandotte, Mich.

Detergent Industry Ponders Products for New Decade

Bruce F. Greek, C&EN Houston

After a decade of developing and introducing new products and formulations, 1990 may be a year in which manufacturers take stock of what they have done and plan what they will be doing in the next 10 years.

Although few major changes are expected in the industry this year, some recent innovations in detergent products will be given extensive test marketing in the U.S. as well as in other parts of the world. If these innovations sell successfully, another round of rapid growth could begin for all of the soap and detergent industry and especially for individual parts of the industry.

Formulations that combine bleaching materials with cleaning materials and other components, for example, are among the products that will get close scrutiny this year. Other such products are detergents and fabric softeners sold in concentrated forms. These concentrated materials, so well accepted in Japan, now are becoming commercially significant in Western Europe.

Although outlooks point to a slowing economy, 1990 probably won't be a bad year for detergent makers and their suppliers. Yet, profitability could be held down as a result of a possible shift in consumer demand toward lower cost detergents in response to a slowing economy and inflation, and a possible failure in the marketplace of innovative products that cost a lot to develop.

Nonetheless, demand and production of detergents and component materials (especially surfactants) are expected to continue rising, with overall consumption growth about matching that of 1989 at 3 to 5%. Some components of detergents (enzymes, for example) likely will grow even more, although use of others, notably the phosphates used as builders, likely will continue to drop.

Lower cost of basic raw materials for making surfactants, other detergent components, and packaging likely will contribute to increased profitability for producers. Both detergent ingredients and packaging components make up the final product sold in the major detergent markets—household cleaners, institutional and industrial cleaners, and personal care products. Basic raw materials, however, are but a small part of the total cost of detergents. Producers of surfactants and plastic containers partially absorbed cost increases in 1988 and early 1989 when ethylene and other basic organic chemicals more than doubled in price. Just as some of those cost increases were passed on last year, some of the price declines may be passed on this year. Industry sources generally regard the impact of changes in basic materials prices as minor in the overall effect on profitability of either detergent ingredients or of products packaged for the consumer.

Consumer sentiment has become increasingly important to profitability. During the past decade, consumers have been willing to pay for better performance and convenience in detergents. More recently they have indicated a willingness to pay more for products that are less harmful to the environment. Yet, in past economic slowdowns, consumers have chosen less performance and convenience in order to pay less for their detergent. Whether consumers now will be slow to accept products more environmentally suitable if their real income declines is uncertain.

Consumers in general are expected to purchase more soaps and de-

Soaps and detergents at a glance

Soaps and detergents are formulated products designed to meet various cost and performance standards. The formulated products contain myriad components, such as surfactants to tie up unwanted materials, builders to improve surfactant processes and to remove calcium and magnesium ions, and bleaches to increase reflectance of visible light. They also contain various additives designed to remove stains (enzymes), prevent soil redeposition, regulate foam, reduce washing machine corrosion, brighten colors, give an agreeable odor, prevent caking, and help processing of the formulated detergent.

Sales: Estimated at about $11 billion in 1989, up from $10.5 billion in 1988. Expected to rise 3 to 5% in 1990

Production: Key detergent ingredients—surfactants—will total about 7.8 billion lb in 1990, up about 3% from 7.6 billion lb output in 1989

Producers: About 200 companies make components and finished products. Sizes range from tiny specialty manufacturers to major producers with detergent sales of over $1 billion. Chemical companies dominate the output of surfactants and components; formulators dominate final production and distribution

Manufacture: Numerous processing steps between basic materials for surfactants and other components that are used to improve performance and desirability. Ethylene, propylene, benzene, natural oils, ammonia, phosphate rock, trona, chlorine, peroxides, and silicates are among the various basic materials. Final formulation involves both mixing and chemical reactions

Prices: Average unit value for 58% of surfactant production (7.3 billion lb) sold in 1988 was 54 cents, up from 44 cents in 1987, according to U.S. International Trade Commission. Estimates of the prices of other components used in detergents aren't available

tergents this year than they did last year. In 1989, the value of product shipments reached $11 billion, up 4.4% from the total in 1988, or 2.5% in constant 1987 dollars, according to estimates of Leo R. McIntyre, chemical industry specialist in the Department of Commerce. This increase was less than half the 9.9% growth in 1988.

The value of surfactants shipped last year, however, increased about 14%—triple the rate for soap and detergents—to an estimated total of $3.65 billion. That growth was slightly higher than the 13% increase of 1988 over 1987.

The growth rate for all of the products containing surfactants and other ingredients used in soaps and detergents was 6.5% in 1989, to more than $37 billion. This group of products includes soap and other detergents, polishes and sanitation goods, surface-active agents, and toilet preparations.

Exports and imports account for relatively small portions of the soap and detergent industry. The Department of Commerce estimates that exports of soap and detergents in 1989 totaled $140 million, up about 4.5% from the previous year. Imports, at $86 million, increased 2.1% over 1988.

McIntyre forecasts that shipments of soap and detergents in 1990 will increase another 2.5% in constant dollars. Exports likely will increase 3.6%, and imports may rise a small amount. Liquid laundry detergents, a fast-growing segment of the detergents market, likely will post a 16% gain in shipments in 1990, to $1.8 billion. Shipments of liquid dishwashing detergents probably will grow even faster, 21% over 1989.

McIntyre predicts that in the longer term, shipments will continue to grow at an average of 2.5% per year in constant dollars through 1994. Heavy-duty liquid laundry detergents will exceed 40% of the market by 1994—compared with about 38% this year—spurred in part by increasing bans on use of phosphate builders in detergent formulations. Consumers frequently shift to liquid formulations in areas where phosphate materials are banned from detergents because they perceive that the liquid detergents give better performance than powdered detergents without phosphates.

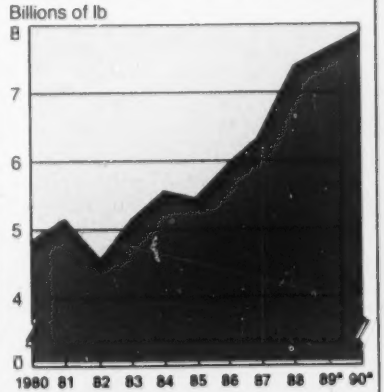
In other areas, McIntyre expects nonchlorine bleaches will eventually replace chlorine bleaches. Materials, such as the peroxygen bleaches, will get a boost when technology develops to activate them effectively at low wash-water temperatures, thereby extending their use to all laundering conditions.

In fuel markets, detergent formulations such as gasoline additives that limit buildup of deposits in automobile engines and fuel injectors likely will grow fast from a small base. McIntyre forecasts the value of such additives, including detergents, will grow 7% annually through 1994, when consumption will be worth about $150 million.

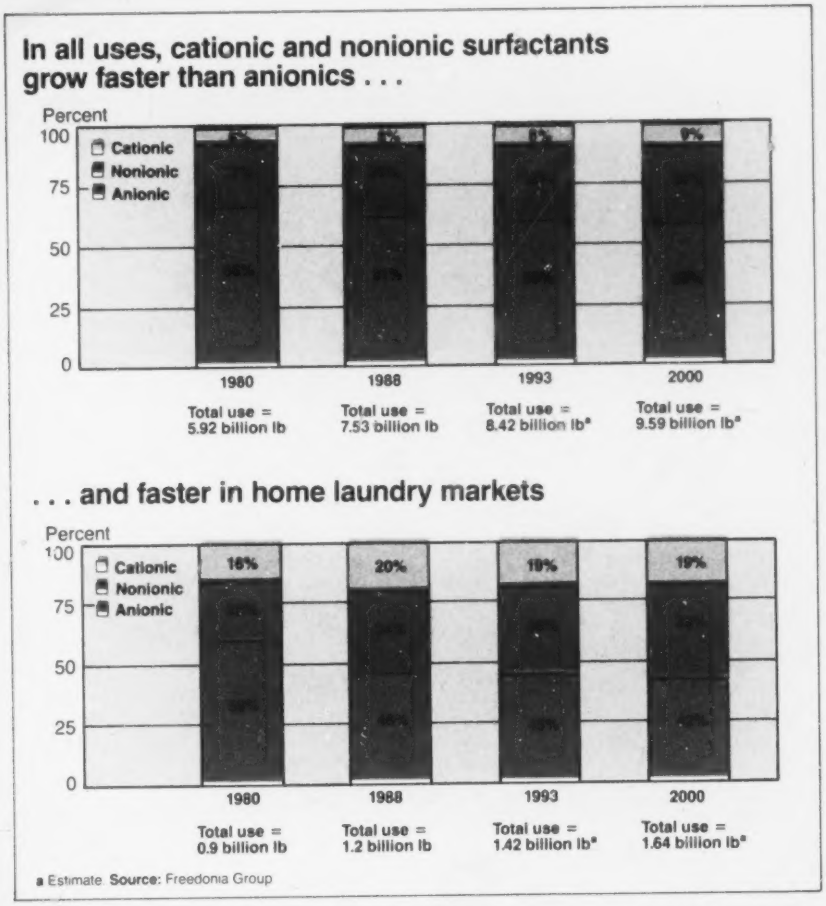
For surfactants, worldwide consumption will be about 15.5 billion lb this year, McIntyre estimates, with about half consumed in the U.S. Roughly one third of U.S. consumption goes to making detergents, with the remainder going into emulsifiers and wetting agents. Both exports and imports of surfactants increased strongly in 1989, reaching $290 million and $300 million, respectively. More growth is forecast for 1990, with exports and imports totaling about $350 million each.

Longer term, the outlook for surfactants is for a growth in shipments of 3.8% annually in constant dollars through 1994. Prices for surfactants made using ethylene are expected to decline in 1990. A prof-

Organic surfactants output has risen since 1985



a Estimate. **Sources:** U.S. International Trade Commission, C&EN estimates



it squeeze could cause some of the smaller producers to cease output.

Surfactants are considered to be the key ingredient of soaps and detergents. Other components such as builders, bleaches, optical brighteners, enzymes, and fillers are needed to provide the cost and performance characteristics that make detergents acceptable in very competitive markets. Not all of these components go into every formulation. Some of the formulations sold to industrial markets, for instance, may contain only a single surfactant and a diluent. Such products are now considered rare because performance needs have led to complex formulations for products sold into the three major-use categories for formulated products.

Soap now has become a small part of the total output of surfactants. According to the U.S. International Trade Commission (USITC), surfactant production in 1988 was 7.3 billion lb. That total likely grew to 7.6 billion lb in 1989, and probably will increase further to 7.8 billion lb this year. Growth in surfactant output last year held in the 3 to 5% range, well below the sizeable growth of 17% in 1988; 1990 is expected to have similar growth. Output of surfactants has not declined since 1985, when it fell 2.8% as a result of a slump in industrial demand.

Of the more than 7.3 billion lb of surfactants produced in 1988, anionic forms, the active ingredient of which is a large carboxylate or alkyl sulfate radical, accounted for more than 60%. Running a distant second were nonionic forms, those that do not undergo electrolytic dissociation in water, accounting for 28% of the total. Cationic surfactants, where the working material is a cation, took 9.6% of the total, and the tiny group of amphoteric surfactants, compounds with both anionic and cationic properties in aqueous solutions, accounted for only 0.6% of total production.

Soaps, all anionic surfactants and alkali salts of carboxylic acids obtained from both natural and synthetic sources, made up more than 17% of total surfactant output. Sulfonates, salts of sulfonic acids largely made with alkyl benzenes and other aromatics, lignin, and other materials, were more than 31% of surfactant total. Various esters made by sulfating long-chain alcohols and ethers accounted for nearly 13% of the total surfactant output.

Among the various nonionic surfactants, various ethers (ethoxylated phenols and linear alcohols) were about 19% of total surfactant production. Carboxylic esters and amides, such as sorbitol-fatty acid esters and diethanolamine condensates, account for the remainder of nonionic output.

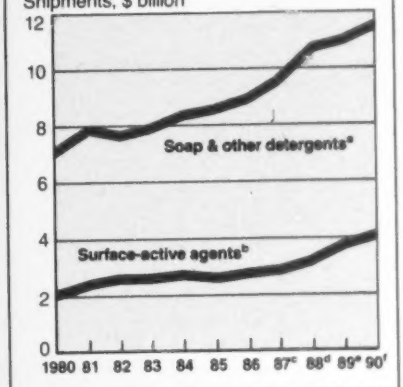
The near-term outlook for surfactant demand growth is a continued moderate annual average. Longer term, most sources expect growth to be lower than during the past five years. Whereas growth in the late 1980s averaged about 4% annually, growth in the first half of the 1990s may drop a third.

In a recent study of the U.S. surfactants industry, Freedonia Group, a Cleveland-based consulting firm, concludes that surfactants demand between 1988 and 1993 will grow 2.3% per year. By 1993, demand will total 8.5 billion lb of surfactants, worth about $4.6 billion, according to the study. During that six-year period, annual price increases will average 3.7%. By 2000, the demand will reach 9.68 billion lb, worth nearly $6.7 billion, Freedonia estimates.

This growth will result largely from consumption increasing faster than population, according to the study, continuing a long-established trend. In 1980, average demand per capita for surfactants was 26.2 lb, with total demand of more than 5.9 billion lb. By 1988, per capita consumption had increased to 30.9 lb and likely will increase to 33.1 lb in 1993 and to 36.0 lb in 2000. Population, meantime, is expected to grow 0.9% annually between 1988 and 1993.

Surfactants growth will be highest for use in products going to the household market. That market, however, will remain smaller than the industrial market, despite the

Value of cleansing agents shipments continues rising



a Standard Industrial Code 2841. b Standard Industrial Code 2843. c Preliminary. d Estimates by Department of Commerce. e Forecast by Department of Commerce. f C&EN estimates. **Sources:** Department of Commerce, C&EN estimates

faster growth. According to the Freedonia Group study, industrial uses in 1988 took almost 54% of the markets for surfactants, with household products taking slightly less than 30% and personal care products consuming the remainder. By the year 2000, industry uses of surfactants will rise slightly in market share, household uses will exceed 30% of the market, and the personal care products share will decline, the group says.

Two developments will largely account for the higher growth anticipated in the household demand sector of the surfactant markets. The first will be the greater concentrations of surfactants going into laundry detergents to meet cleaning requirements while washing at lower water temperatures. The second is that liquid detergents, which are generally higher in surfactant concentrations than powdered detergents, will continue to increase their market penetration during this decade, even though the major growth spurt is over.

The industrial market for surfactants will have average growth in most categories, according to Hans Kuenzel, a Freedonia research analyst. Special situations in the industrial sector involving personal contact and technical service lead to development of proprietary and highly specific surfactants. The industrial market contrasts with the household surfactant market in that it is highly fragmented, having a large number of small producers serving many customers. The household market, on the other hand, consists of a few manufacturers of detergents and cleaners supplied by a few large surfactant producers.

The industrial market covers a wide range of industries—including those that make petroleum products (including asphalt manufacture), agricultural and food products, coatings, textiles, and pulp and paper products. A large volume of various surfactants also is used in producing oil and gas, especially to enhance recovery.

Personal care product markets for surfactants will grow slowly because of a stagnation in soap demand. Liquid soap sales have plateaued, according to Kuenzel, and future growth depends on marketing emphasis and packaging innovations. Opportunities for growth in these markets are best in the nonirritating surfactants. Expanding demand for multifunctional products, such as shampoos and conditioners, will give better growth to this class of surfactants.

Many of the surfactants developed for household detergents eventually find use in formulations sold industrially or in personal care products. Because of efforts to maintain positions in the highly competitive household detergent and cleaner markets, much of the development work in surfactants is done in formulated detergents.

The procedure for developing new surfactants and other components of detergents has changed for many suppliers, as has the procedure for providing new materials for other industries. For instance, Du Pont now works from the markets back to products rather than finding markets for newly developed products. The aim now is to provide products and systems for using those products to meet strategic markets, says Phillip M. Richardson, market manager for Du Pont's cleaning products department.

Basically, the marketing plan is directed toward helping customers and consumers meet their needs, Richardson says. The first step is to understand the needs and desires of consumers. Technology developed by Du Pont over many years then will be used (modified or fine-tuned as necessary) to change products to meet the users' needs. As the detergent formulations grow more complex, formulators will look more to suppliers for technical help in both distinct products and in systems to make the final products.

New surfactant development is but one of the challenges that face producers. New competitors with different motivations and feedstocks, worldwide competition and global marketing, growing environmental awareness, and increasingly complex formulations for detergents are some of the other challenges, says W. Jan B. Vogel, vice president for surfactants at Vista Chemical. Speaking to a joint American Oil Chemists Society-Chemical Specialties Manufacturers Association (AOCS-CSMA) conference on new horizons in the industry late last year, he noted that surfactants made from linear alkylates and alcohols that are subsequently sulfonated, sulfated, or ethoxylated, could be particularly affected.

Excluding soap, lignin derivatives, and the various cationic surfactants, derivatives of these intermediates (linear alkylates and linear alcohols) will be about 60% of the 3.5 billion lb of surfactants consumed annually in the U.S. and Canada. The other 40% includes many other surfactants, such as fatty acid esters, amides, alkylphenol ethyoxylates, the amphoterics, and block polymers of ethylene and propylene oxide. The linear alkylate and alcohol derivatives account for more than 90% of the surfactants used in the household products markets.

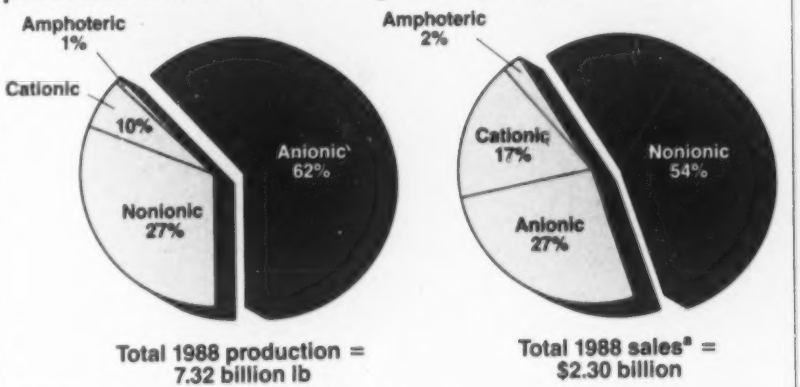
U.S. producers predominantly supplied the U.S. and Canada demand for alkylate and alcohol derivatives for surfactants in detergents until 1986, Vogel says. Now 5 to 10% of the demand is supplied by imports, largely from Western Europe and Third World nations. (Most new capacity to make these products has been built in the Third World or newly industrialized nations.) Overcapacity has now resulted partly because suppliers, particularly those in Western Europe that formerly exported to developing nations, lost

their export markets. Capacity beyond that needed to meet current domestic demand was built in Third World nations, adding supplies for export in competition with existing suppliers, further increasing overcapacity. The trend will continue because all but one of the plants planned or under construction are located outside the U.S., Western Europe, and Japan.

New capacity for making natural oil-based alcohols (made using coconut or palm kernel oil) also is coming, Vogel points out. Of more than 500 million lb announced new capacity for these natural alcohols, 400 million lb will be coming on stream within the next three years. Much of the current capacity of about 1.1 billion lb, for a while, will be sold in world markets. The result will be a shift in raw materials for alcohols used for making surfactants—from the current dominance of ethylene-based synthetic alcohols to about equal amounts of alcohols from ethylene and natural oils.

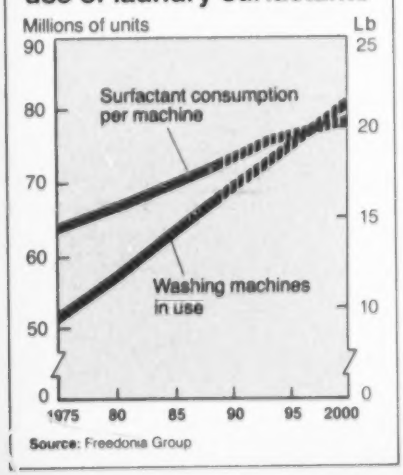
In the past, natural oil-based alcohols have had small impact on U.S. supply and price of surfactants. For the past 10 years, the cost of coconut oil (until now, the predominant source of natural alcohols for surfactants) has varied so widely that it has not established a sustained edge over ethylene-based alcohols. The less-than-competitive pricing of natural oil alcohols compared with ethylene-based alcohols may change, Vogel adds. Far more coconut oil has been available than palm kernel oil, the other major source of natural lauric oil. But, when the many new palm trees planted in the Western Pacific countries mature, Vogel expects that palm kernel oil output will jump to about 3.4 million tons in 2000, up from about 1.2 million tons in 1990. This output will be close to the expected coconut oil output of about 3.7 million tons. Two competing sources of lauric oil likely will stabilize prices, particularly since palm kernels are largely a by-product.

Anionics comprise almost two thirds of U.S. surfactant production while nonionics grab majority of sales



a Sales of 4.26 billion lb. **Source:** U.S. International Trade Commission

Use of machines outpace use of laundry surfactants



Source: Freedonia Group

Production from the natural oil-based alcohol plant being built by Henkel in Cincinnati (with a capacity of 35,000 tons per year when completed in early 1992) partly will go to increase the production of a recently developed class of surfactants—the alkyl polyglycosides. About the same time that the alcohol plant will be completed, Henkel will start up a new 40 million lb-per-year plant at the same site, to make the glycoside surfactants, according to Gary W. Granzow, executive vice president of Henkel's APG™ surfactant group. Henkel made development quantities of these surfactants in a 2.5 million lb capacity unit at Crosby, Tex., in 1986 and expanded capacity to 10 million lb in 1988. After the new unit is on stream, the smaller unit will be moved to Cincinnati to be used in making various specialty glycoside surfactant products.

The glycoside surfactants technically are nonionics, Granzow says, but some show anionic characteristics. They have a variety of properties (depending on chemical composition) that allow them to be used in detergents for all three major markets. Some of the glycoside surfactants will tolerate a wide range of pH, from 3 to above 12, making them suitable for many industrial detergent formulations. Others are high foamers, suitable for shampoos in the personal care products market. For the larger volume uses, prices are expected to be competitive with the alcohol ether sulfates.

Another line of surfactants based on natural oils is expanding in the various detergent markets for use in combination with other materials. This is a class of alpha-sulfo methyl esters, often the laurate, developed by Stepan, a large producer of sulfonated derivatives for use as surfactants. The laurate derivatives as surfactants initially show most advantage for use in liquid household laundry detergents, says Edward H. Buening, senior business manager for industrial products. Others in this class are being developed for other markets.

The laurate ester can be combined with conventional soap and other components in making a formulated detergent with good cleaning properties, Joseph C. Drozd of Stepan told the AOCS-CSMA conference. The ester overcomes problems of using soap in hard water, difficulties from precipitation of calcium and magnesium soaps that

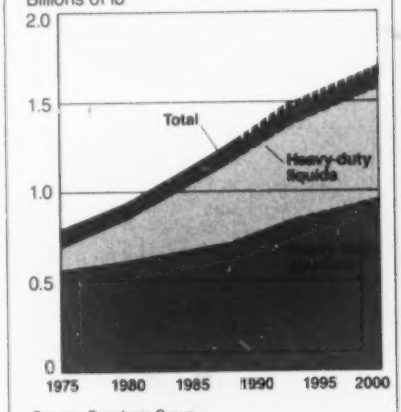
dull fabrics and surfaces, poor cleaning in cold water, and low solubility. Prior to this development, soap had experienced about a 50-year hiatus in its use in any home laundering detergents.

Soap in formulated detergents was largely replaced after World War II by alkylbenzene sulfonates. Branched chain alkyls were used first, and later linear chain alkyls. The linear alkylbenzene sulfonates (LAS) rose rapidly in demand and by 1970 accounted for a large share of surfactant consumption in household detergents. At that time, many other classes of surfactants began coming to the marketplace, limiting growth of LAS. LAS output languished in the 600 million to 700 million lb range for about 15 years, slowed partly by the price increases in benzene and kerosene (the source of the linear chain alkyls) as a result of the oil crises. As liquid heavy-duty laundry detergents gained wider acceptance, LAS began to grow again. In 1988, production of alkylbenzene sulfonates totaled more than 819 million lb, up 11% from production in 1987, according to USITC.

The growth spurt for LAS came on the heels of the higher costs of other surfactants based on ethylene, the cost of which rose rapidly during 1988, according to Cornelia A. Schirber, a business analyst for surfactants at Vista Chemical. Though temporary, the higher cost of surfactants such as alcohol ethoxylates (AE) changed the cost/performance factors involved in formulating detergents. Surfactants are selected for performance factors according to several factors including the type of detergent to be made, the cleaning performance expected of the detergent, and the detergent maker's own processing system and costs.

Most formulations now made combine various surfactants to get the desired performance, taking into account the influences of other components of the detergent such as builders or enzymes. By doing so, detergent producers can overcome differences in properties of individual surfactants. According to Schirber, important differences between LAS and AE are that LAS foams higher and more effectively cleans particulate soils and cotton fabrics, but is less effective on oily soils. And it is easier to spray dry (if making a powdered detergent) and more sensitive to water hardness.

Liquid detergent growth in home markets slows



Source: Freedonia Group

A shift to liquid detergents over the past five years has led to a substantial AE demand growth also because relatively few of these surfactants are used in powdered detergents, Schirber points out. But because liquid detergents contain about twice as much surfactant per wash load, the whole surfactant demand grew with the shift to more use of liquid detergents.

Despite these and other factors affecting surfactant demand, the respective costs of LAS and AE more often influence which is used in detergents. The competition between these two tends to stabilize prices, Schirber concludes. The competition in price, however, will be influenced in the future by the availability of increased supplies of natural oils that can be made into AE. However, the impact will be dampened by the cost of ethylene oxide, a synthetic material, used in making AE-containing alcohols from natural oils.

The outlook for AE and other

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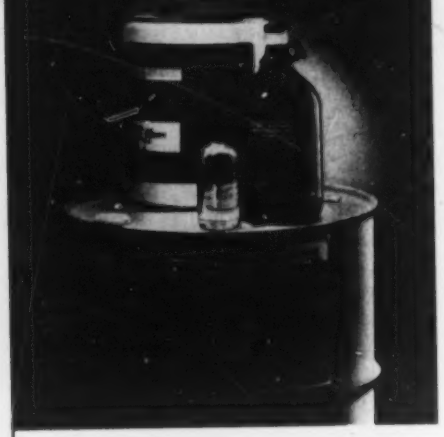

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alcohol-based surfactants remains good, according to Jerry G. Moffett Jr., business manager for detergent products at Shell Chemical. He forecasts a growth of at least 3% in demand for the alcohols in 1990, with possible higher increases owing to cost/performance factors. For instance, more use of enzymes in heavy-duty liquid household laundry detergents is raising demand for alcohol ether sulfate surfactants. The large decline in ethylene prices during the second half of 1989 is cited by Moffett and other industry sources as an aid to more use this year of surfactants based on synthetic alcohols.

Although raw material costs for synthetic alcohol surfactants are lower, the LAS surfactants will continue to grow at about the same rate, Vista Chemical's Vogel says. He notes that, beginning this year, no major reformulation away from LAS will occur and adds that this class of surfactant remains very cost-competitive.

Anthony J. Zoglio, business manager for surfactant intermediates at Monsanto, expects use of LAS materials for detergents to grow 3 to 4% this year, above the overall rise in demand for detergents that will be in the range of 1.5 to 2%. He cites increasing bans on the use of phosphate builders as helping demand for LAS. Use of liquid laundry detergents reaches 60% of detergent sales in areas of phosphate bans, well above the level of use in areas where phosphate builders are allowed in detergents. Because liquid detergents contain much higher concentrations of surfactants than powdered detergents, surfactant demand is boosted more than could be expected from detergent demand growth forecasts.

Changes in the use of builders resulting from environmental concerns have been pushing surfactant demand longer than the shift toward liquid detergents. Outright legal bans or consumer pressures on use of inorganic phosphates and other materials as builders generally have led formulators to raise the contents of surfactants in detergents. No clear measure of how important the bans are on increasing surfactant consumption compared with the shift toward liquid detergents has emerged, mainly because both actions are on-going.

Following addition of fragrances, milling converts soap to uniform flakes

But it does seem clear that, for this year and longer term, use of phosphates as builders in detergents for household use will decline. Builders, however, will continue to be an important component in formulated detergents because of their cost/performance characteristics. Builders in detergent formulations

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provide several functions, most important of which are to aid the detergency action and to tie up and remove calcium and magnesium from the wash water, dirt, and the fabric or other material being cleaned. Besides sodium and potassium phosphates, other builders that may be used in the various detergent formulations are citric acid and derivatives, zeolites, and other alkalis. For detergent manufacturing reasons, some builders are impractical for some uses. For example, citric acid causes caking in powdered detergents, making the free flow in filling lines difficult, yet it finds considerable use in liquid detergents.

Demand in 1990 for phosphate builders will be down about 3% overall, says Michael J. Berezo, business manager for builders/polyphosphates at Monsanto. Because of the expanding geographical area in which phosphate builders are expected to be banned, the use of phosphates in heavy-duty laundry detergents will be down about 5%. However, a slight increase in demand for these builders is expected for use in detergents going into the industrial and institutional markets and into automatic dishwashing detergents.

While agreeing with forecasts of flat growth to a modest overall decline in phosphate demand, Lewis G. Furman, marketing director of FMC's phosphorus chemicals division, expects a 1 to 2% increase in phosphate builders for the industrial and institutional and the dishwashing detergent markets. FMC also notes that new multifunctional household detergents containing bleaching materials and formulated with phosphates, continue to be introduced.

The company continues to oppose bans on use of phosphate builders because it does not believe there is conclusive evidence to indicate that bans result in improved water quality. Phosphates continue to offer the greatest performance benefit at the least cost to the consumer, FMC maintains. Comprehensive data are not as yet available on environmental acceptability of substitutes for phosphates.

In the field of industrial and institutional detergents, a shift from powdered to liquid formulations also has occurred, says Peter P. Carfagno, detergents products technology manager at FMC's research and development laboratories in Princeton, N.J. When it became clear how limited the concentrations could be in liquid products, a shift toward suspensions and slurry forms developed. These forms of detergents had to be metered and delivered to the cleaning site, leading to worker safety issues relating to the aggressive, often caustic-containing, formulations at the actual point of use. To overcome such potential problems, FMC developed formulations cast in pastes, gels, and block or other solid forms.

In some detergent formulations, larger and larger amounts of soda ash (sodium carbonate) are replacing inert ingredients, says William L. Breunig, marketing director in FMC's alkali chemicals division. An 18% increase in the use of soda ash during the past three years is attributed to its functionality as a builder, an agglomerating aid, a carrier for surfactants, and a source of alkalinity. Cost pressures on alternative materials also are involved. Cleaning compounds now annual-

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Numerous major producers supply large-volume surfactants

Surfactants	Producers
AMPHOTERICS	Alcolac, Du Pont, Henkel, Lonza, Miranol Chemical, Mona Industries, Sherex Chemical
ANIONICS	
Carboxylic acids and derivatives (largely based on natural oils)	Alcolac, Exxon Chemical Americas, Henkel, Lever Brothers, Procter & Gamble
Sulfonic acid derivatives (alkylbenzene sulfonates and other sulfonates)	Alcolac, Colgate-Palmolive, Desoto, Dow Chemical, Du Pont, Lever Brothers, Procter & Gamble, Stepan, Vista Chemical, Witco
Sulfuric acid esters and salts (largely sulfated alcohols and ethers)	Alcolac, Du Pont, Henkel, Lever Brothers, Lonza, Shell Chemical, Stepan, Vista Chemical, Witco
CATIONICS	
Amines and derivatives	Akzo, BASF, Du Pont, Enenco, Exxon Chemical Americas, GAF, PPG Industries, Procter & Gamble, Sherex Chemical, Witco
Quaternary ammonium salts	Alcolac, Akzo, Du Pont, Exxon Chemical Americas, PPG Industries, Sherex Chemical, Witco
NONIONICS	
Carboxylic acid amides and esters and derivatives	Alcolac, Ardmore Chemical, GAF, Henkel, ICI Americas, Lonza, PPG Industries, Quantum Chemical, Sherex Chemical, Stepan, Witco
Ethers (alkoxylated—especially ethoxylated—alcohols)	Alcolac, BASF, Du Pont, Exxon Chemical Americas, GAF, Henkel, ICI Americas, Monsanto, Olin, Procter & Gamble, PPG Industries, Quantum Chemical, Rohm & Haas, Sherex Chemical, Stepan, Texaco Chemical, Union Carbide, Witco

Source: U.S. International Trade Commission

ly consume more than 800,000 tons of soda ash, about 11% of the total U.S. market.

New and reformulated detergent products have created the need for more specific and unique characteristics in the soda ash product, according to Jeffrey J. Prickel, soda ash product manager for detergents in the same division of FMC. The company makes sodium carbonate by both the monohydrate and sesquicarbonate processes and is the only U.S. producer using the latter process, he adds. The sesquicarbonate process allows special grades of soda ash for various detergent industry requirements to be made, and results in better rates of hydration, flowability, high absorptivity and purity, and variable bulk density.

Incorporating bleaching agents into detergent formulations for home laundry has accelerated, as producers find test marketing results favorable and expand the availability of these "detergents with bleach" to national-scale. Such a multifunctional product can be sold successfully because of cost/performance considerations. Higher cost of such a product is justified by consumers because its performance allows users to curtail the need to store as well as add (as a second step) bleaching material.

Because U.S. home laundry uses shorter wash times and lower temperatures than European home laundry, chlorine bleaches (mainly sodium hypochlorite) have long dominated the bleach market in the U.S. Institutional and industrial laundry bleaching, where done, also has favored chlorine bleaches (often chlorinated isocyanurates) because of their rapid action. Growth in consumption of these bleaches in household markets has followed population growth for the past decade.

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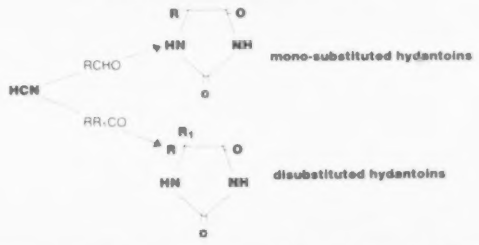

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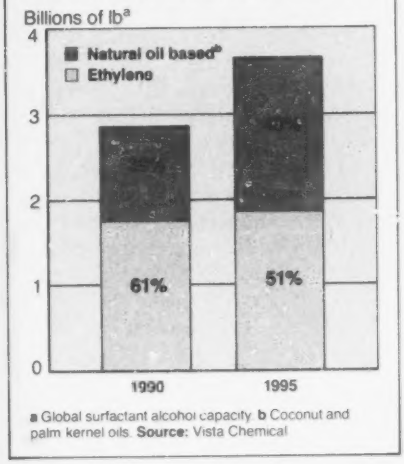
Natural oils to gain as surfactant alcohols source



a Global surfactant alcohol capacity. b Coconut and palm kernel oils. **Source:** Vista Chemical

Other kinds of bleaching agents used in the detergent markets are largely sodium perborates and percarbonates, other than hydrogen peroxide itself. The perborates far exceed use of percarbonates in nonchlorine bleaches added separately to wash water or to a detergent formulation. The peroxygen bleaches are forecast to grow rapidly, for both environmental and technical reasons, according to various industry sources. Currently about 125,000 tons of the various peroxygens are consumed in detergent products, according to John Medina, director of peroxygens marketing at Degussa.

Regulatory pressures will drive the institutional and industrial market away from chlorine bleaches and toward the peroxygen bleaches, Medina says. The Clean Water Act amendments are requiring lower levels of trihalomethanes (products of reaction of organics and chlorine) in wastewater. Expensive systems may be needed to clean up effluents, or the industrial users of chlorine bleaches will have to pay higher and higher surcharges to municipalities for handling chlorine-containing wastewaters that are put into sewers.

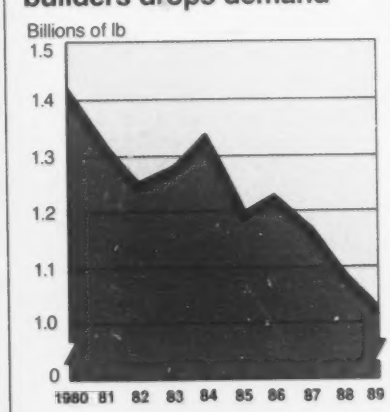
The shift toward liquid peroxygen bleaches has stabilized and is growing at about the rate of the gross national product, says Medina. The trend is toward solid peroxygens in a fully built detergent plus bleach that now is nationally available. Degussa is offering a sodium perborate monohydrate that the company says solubilizes easier and has a higher oxygen content that gives faster bleaching with the shorter wash cycles in the U.S. However, he adds that better activators are needed to give better bleaching at the short cycles combined with temperatures below about 60 °C.

The success of detergent-bleach combinations has spurred FMC to expand various research and development activities in such areas as systems to add peroxygens to cleaning applications where they have not been used before and to find alternative methods to add peroxygens to both powder and liquid detergent formulations, says Quentin Hopkins, industry manager at FMC's R&D department. None of this work has yet led to commercial products.

Current and expected changes in bleaching materials for various segments of the detergent industry are but part of what many industry sources call sweeping changes coming, due to environmental concerns and responses to efforts to improve the world environment. The so-called green movement that is seeking more environmentally acceptable products in Europe and Canada has gained enough momentum to be a factor to be dealt with in the U.S. in 1990, says Michael W. Buettner, marketing manager for BASF's performance chemicals.

Both detergent makers and their suppliers will devote greater efforts

Ban on STPP, TSPP as builders drops demand



Note: STPP is sodium tripolyphosphate; TSPP is tetrasodium pyrophosphate. **Source:** FMC Corp.

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Machine operators use heavy-duty detergents for cleaning equipment

to develop more "environmentally friendly" products, he predicts. Preference will be given to such products by mass merchandisers, and manufacturers will be quick to respond, he adds. One example of attention to the trend in Europe is BASF's development of a new biodegradable stabilizer for perborate bleach, which is now being evaluated for use in detergents.

The existing detergent materials known to be environmentally safe and effective will continue to be widely used, industry sources agree. One example of such materials is LAS (and its precursor linear alkylbenzene), which Monsanto's Zoglio cites as being well tested and found nontoxic and environmentally safe. It will be difficult, however, to gain approval for new materials to be used in detergent formulations until their environmental performance is shown to meet current and new guidelines.

Environmental concerns are gaining attention in other ways. Disposing of the container that gets the detergent to the consumer often falls under concerns of handling plastic waste. One approach, begun on a test marketing scale in the U.S. in 1989 is a shift toward concentrated forms of detergents that require smaller containers.

The impact of the concentrates, whether for direct use or for dilution by the consumer, probably will be an increase in consumption of surfactants and other detergent components. On the basis of recommended use volume, no important change in surfactant and other component demand should be expected. But because consumers will have a tendency to overuse a concentrated form (which has happened with liquid detergent formulations), consumption likely will rise relatively.

Major developments in the detergent industry this year will be the growing demand for detergents with bleach as a component and more test marketing of concentrated forms of detergents. But much work on surfactant development and improvement of the many other currently used minor components will continue. Some of these developments will come to market this year, but likely will be barely noted, even by most in the industry. The developments will involve the components other than surfactants, builders, and bleaches. Work will continue on foam regulators, agents to resist soil redeposition, various optical brighteners, enzymes, fabric softeners, solubilizers, activators, and perfumes or other odorants.

All of these developments boost the effectiveness (including convenience) of formulated detergents in response to consumers' demands for even better cost/performance results. The improvements also are increasing the complexity of the formulations, especially those designed to have a high degree of multifunctionality. Despite the difficulties that arise from such complexity, development will go on. Producers of detergents and their components will again this year echo their statements that more new products have come out than ever before. □

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